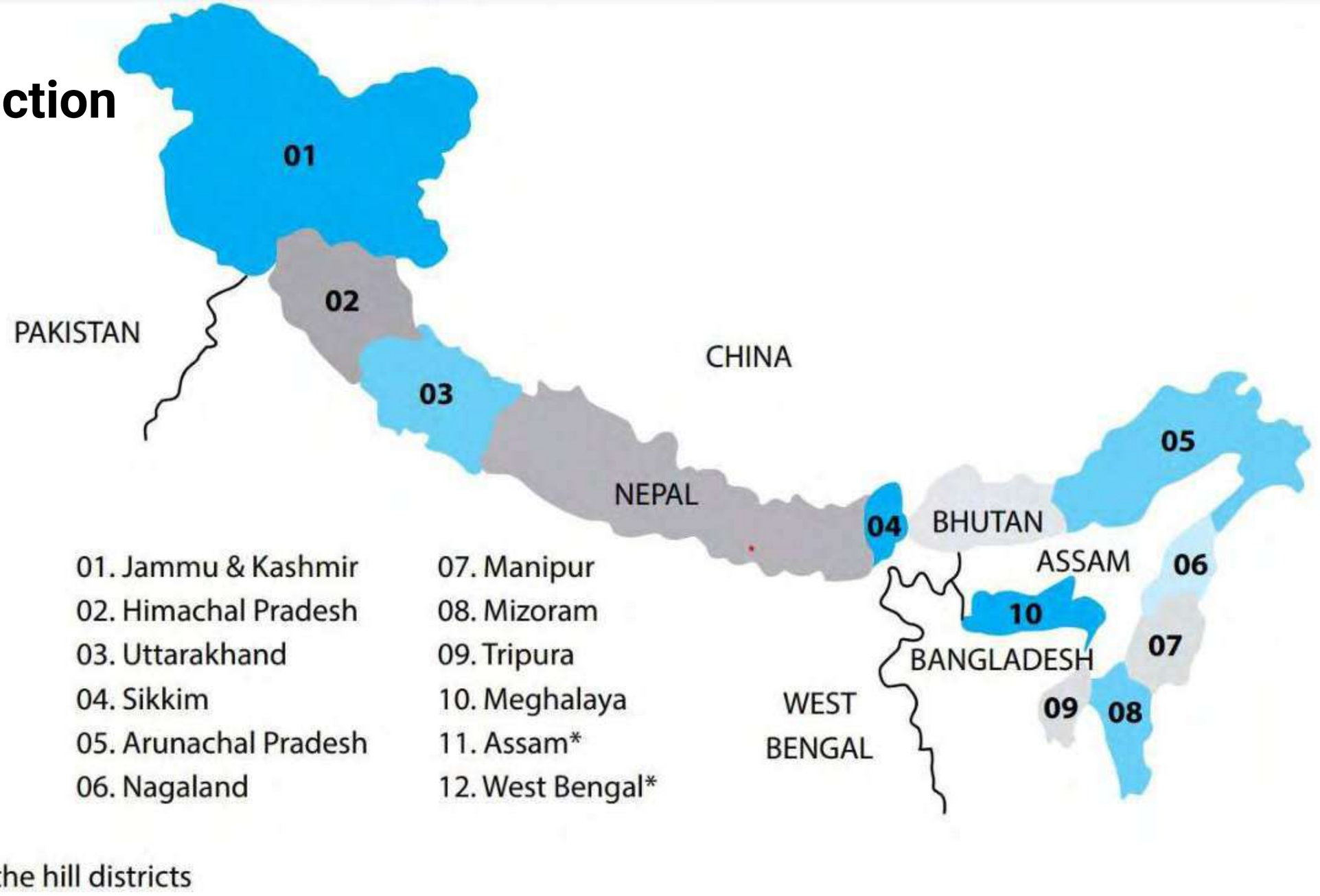
# Vulnerability, Disaster Risk, & Sustainability of Himalayan States-Cases of Uttarakhand and Sikkim Disasters

Prof. Vinod K. Sharma
Senior Professor, Disaster Management, Indian Institute of Public Administration, New Delhi and
Vice Chairman, Sikkim State Disaster Management Authority, Gangtok, Govt. of Sikkim
profvinod@gmail.com

# Introduction




*The Indian Himalayan Region (Source: National Mission on Himalayan Studies)*

# Vulnerability in Himalayan Geographic Context

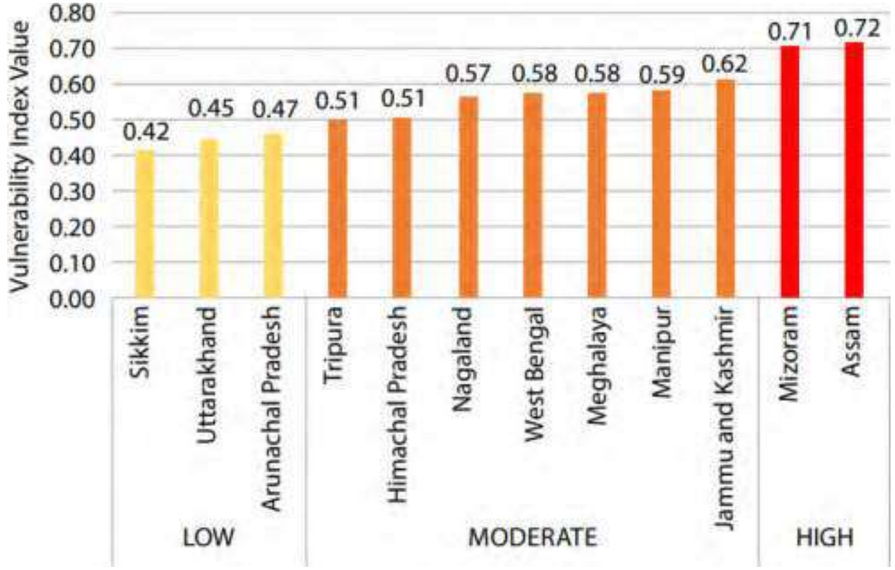
*Vulnerability* refers to **the degree to which the Himalayan region and its communities are susceptible** to the adverse impacts of natural disasters and environmental changes.

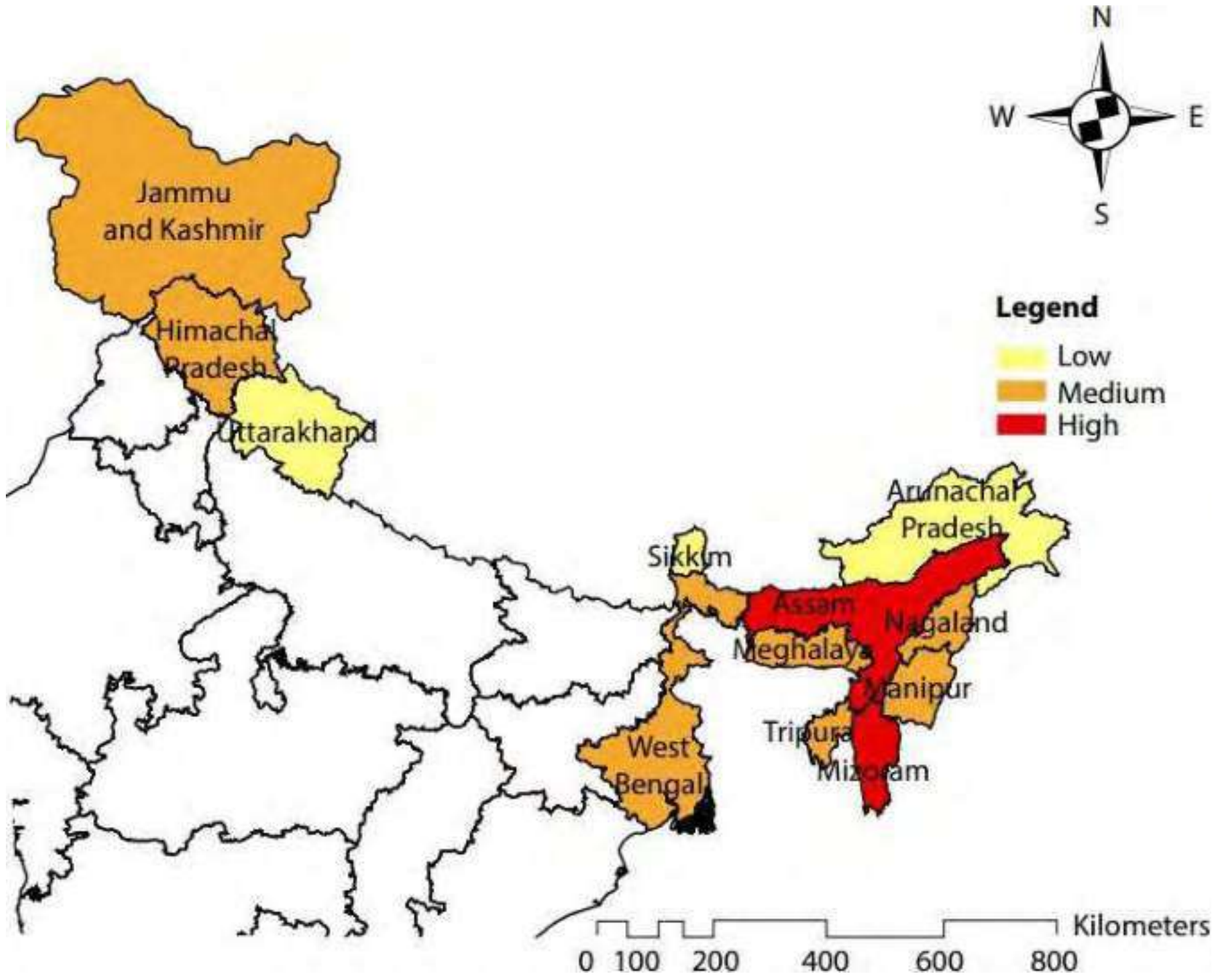
In this context, **it encompasses the fragility of ecosystems, socioeconomic factors, and the capacity of local communities** to cope with and recover from disasters, considering the unique geographic features of the Himalayas

# Vulnerability Assessment in Indian Himalayas

vulnerability assessment methods tailored for the Indian Himalayan region

Factors unique to Indian states contributing to vulnerability




Vulnerability index of IHR States

*source: Climate Vulnerability Assessment for the Indian Himalayan Region Using a Common Framework*

## Himalayan States Main Hazards

Earthquake, Landslides, Forest Fire, GLOF

Total Glaciers in India- 9575

Glaciers in Uttarakhand – 1439

Landmass- 4060 Sq. Km.

Glaciers in Sikkim- 84

Uttarakhand Disaster 2013 (Kedarnath Cloud Burst and Glacial lake burst)
Uttarakhand Disaster 2021 (7 February 2021)
Sikkim Floods 2023 (4 October, 2023)

**GLACIAL BURST LEADS TO MASSIVE FLASH FLOOD IN 2013 AND 2021**

**MASSIVE LIFE AND ECONOMIC LOSS**

**WHAT CAN BE DONE**


Dhak
Lata
Rini
Ringi


KOBELCO


VOLVO
VOLVO

# Recent Disasters in India


**Sikkim Floods**

On 4 October 2023, heavy rains caused the glacial South Lhonak lake in Sikkim, a state in northeastern India, to breach its banks, causing a glacial lake outburst flood. The flood reached the Teesta III Dam at Chungthang at midnight, before its gates could be opened, destroying the dam in minutes. Water levels downstream in the River Teesta rose by up to 20 feet (6.1 m), causing widespread damage. It is the deadliest flood in the area after the 1968 Sikkim floods when around 1000 people were killed.

# Recent Disasters in India

**Uttarakhand Flash Floods**

In 2013, Uttarakhand witnessed devastating flash floods, triggered by heavy rainfall and cloudbursts. The disaster resulted in widespread destruction, loss of lives, and damage to infrastructure. Lessons learned from this event emphasized the need for improved early warning systems, infrastructure resilience, and sustainable land-use planning to minimize the impact of future flash floods in the region.

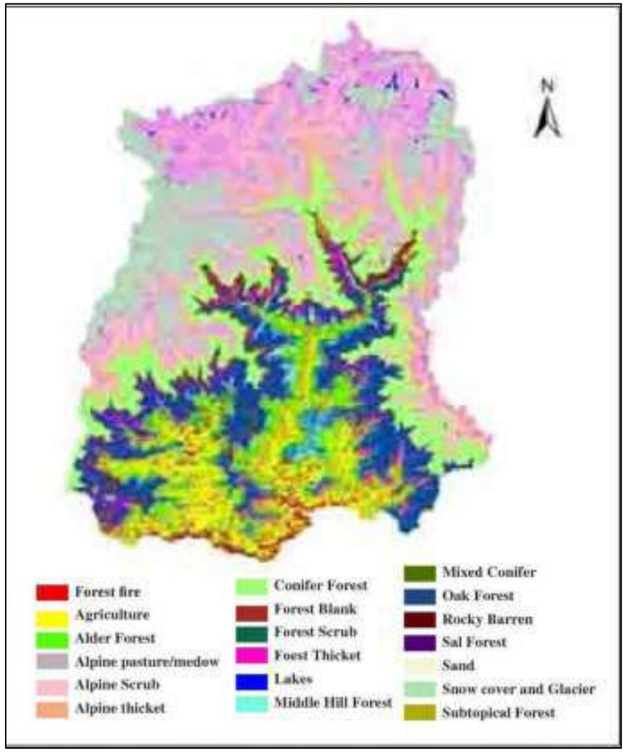
# Recent Disasters in India

**Kedarnath Landslides and Floods**

The Kedarnath disaster in 2013 involved massive landslides and flash floods, particularly impacting the pilgrimage site of Kedarnath in Uttarakhand. The event emphasized the vulnerability of hilly terrains to multiple hazards. Key takeaways include the importance of ecosystem preservation, implementation of robust early warning systems, and community-based disaster preparedness. Strategies should focus on sustainable tourism practices, infrastructure resilience, and effective communication to reduce the impact of such events in the future.

# Recent Disasters in India

Forest Fires in Sikkim




**FOREST FIRES IN SIKKIM HIMALAYAS, INDIA USING REMOTE SENSING AND GIS TECHNIQUES**

# Disaster Risk in Himalayan Geographic Context

*Disaster risk* in the Himalayan context pertains to the **probability of harmful consequences** resulting from natural hazards, such as earthquakes, landslides, and floods.

It takes into account the region's susceptibility to these hazards, the exposure of human settlements and infrastructure, and the vulnerability of communities, **emphasizing the potential for adverse impacts on the Himalayan states.**

# Climate Change Impacts

- Significantly impacting the Himalayan states in India, **manifesting through rising temperatures, accelerated glacial melt, and altered precipitation patterns.ster risk**

- **sensitive ecosystem**, is experiencing temperature increases that contribute to the retreat of glaciers

- The **cascading effects include increased vulnerability** to natural disasters like landslides and floods, posing challenges for both the environment and communities.

*Understanding these specific climate change impacts is paramount for formulating adaptive strategies, fostering sustainable development, and mitigating the risks faced by the Himalayan states in India, ensuring the long-term resilience of the region.*

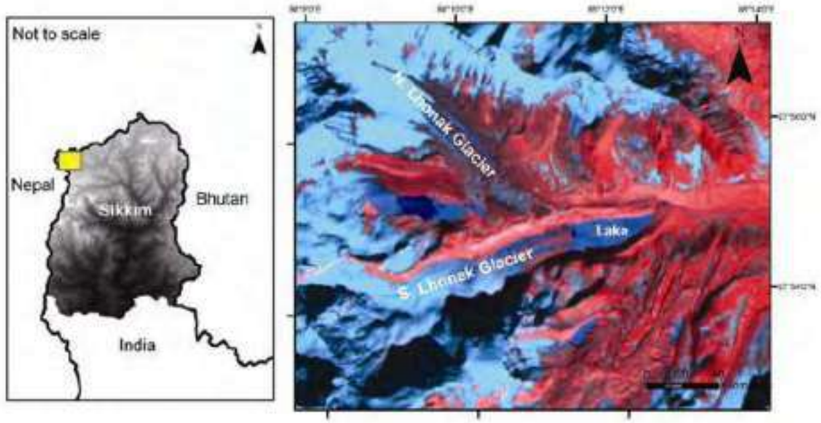

NORTH SIKKIM
WEST SIKKIM
SOUTH SIKKIM
EAST SIKKIM
www.veethi.com

# Lhonak Glaciar in Sikkim

South Lhonak Lake (126 ha) is located at North Western part of Sikkim.

Geographic Location: 27 deg 54’56.7”N and 88 deg 12’35’’E

Altitude : 5245 m




3-D view of South Lhonak Chho, Sikkim (Google Earth 2013)

# Unique GLOF Mitigation Initiative

Situation was first reported in February, 2013.

Scientists from National Remote Sensing Centre (NRSC), Hyderabad published this article in Current Science, Vol. 104, No 3.

It was reported that this Lake is highly vulnerable for GLOF event.

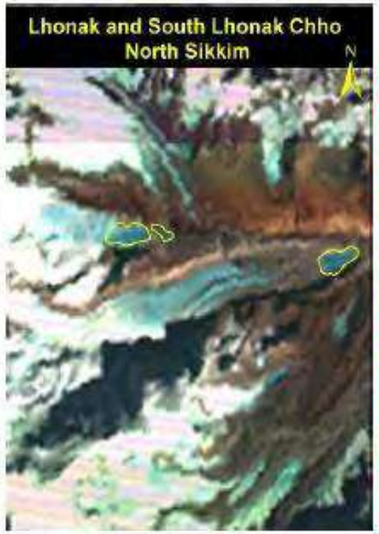
GLOF can cause extensive damage to the natural environment and human property if flooded downstream.

| Time-period | Area of the lake (ha) |
|---|---|
| 1977 | 17.54 |
| 1989 | 37.32 |
| 2002 | 78.95 |
| 2008 | 98.73 |

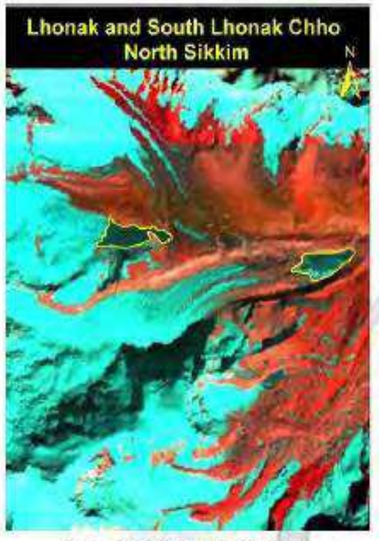
Current Science, Vol. 104, No 3.

# Areal Growth of South Lhonak Chho

USGS CORONA 1965

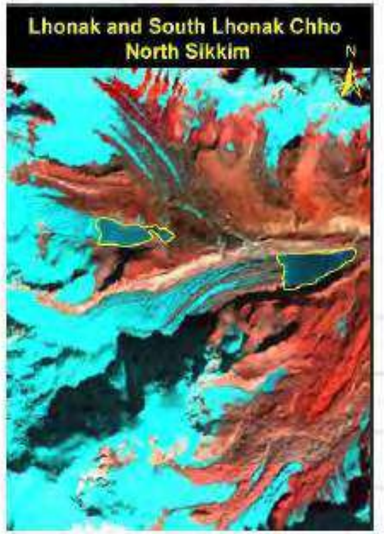


LandSat MSS 1976

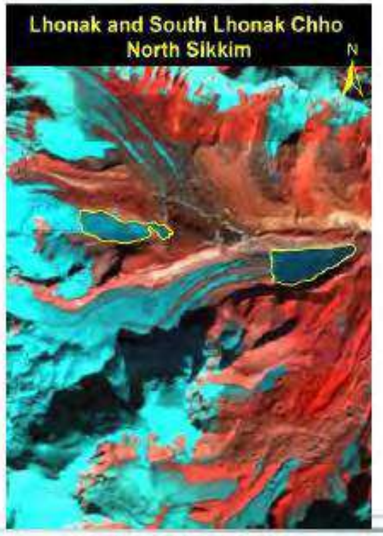


LandSat TM 1989

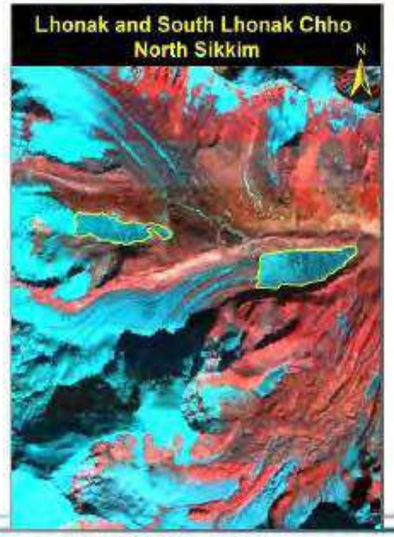
IRS 1C-L3, 1997



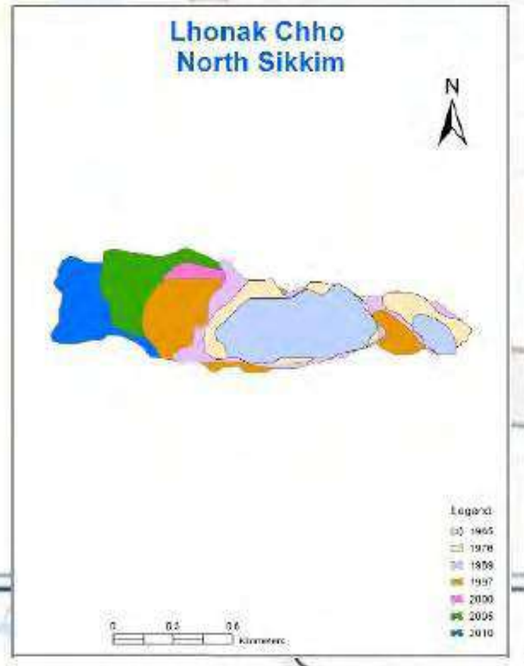
LandSat TM 2000



LandSat TM 2005



IRS P6-L3, 2010

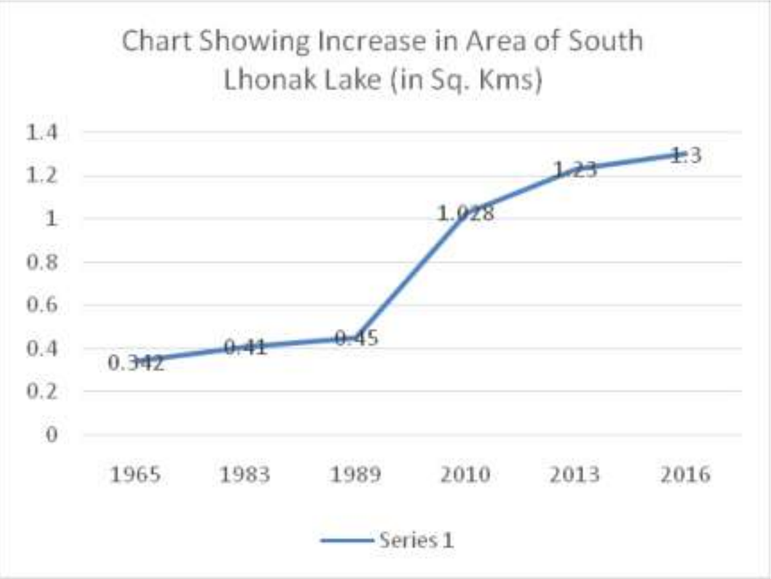



# Problem

The lake has increased from 17.9 hectares in 1979 to 109 hectares in 2011 & 126 hectares in 2013. The continuous expansion of the lake is of concern.

Bathymetric study indicates that the storage volume of the lake to be 536 billion litres of water.

Expansion of lake water towards the outlet indicates increasing pressure at the outlet.




(Source: DST&CC, Government of Sikkim)

# First Field expedition

The first field expedition to study the problem was conducted on August 2014.

The expedition team consisted of members from :

- ✓ Snow and Avalanche Study Establishment (SASE),
- ✓Department of Science and Technology and Climate Change, Govt. Of Sikkim.
- ✓Sikkim State Disaster Management Authority, Govt. Of Sikkim.

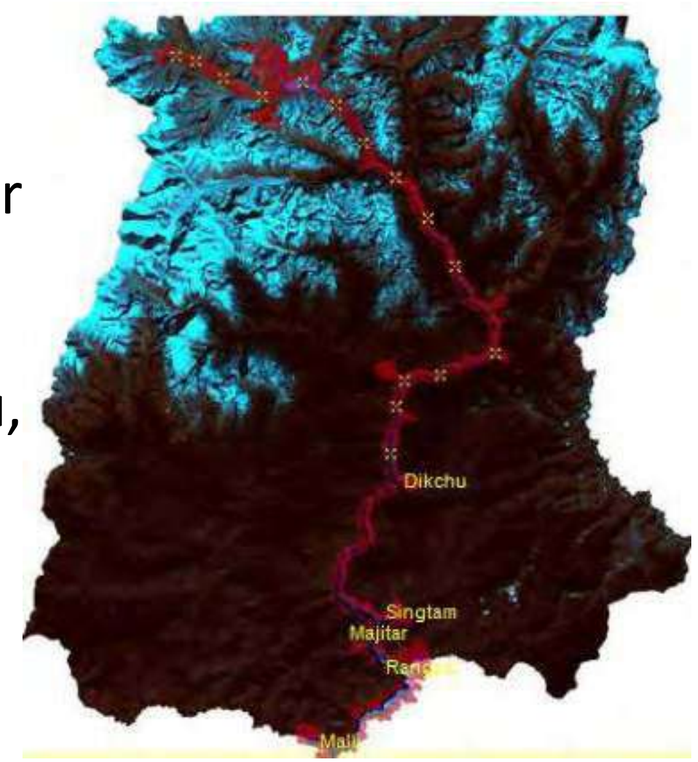
# Threat

Flashflood in downstream areas.

Important infrastructure like dams, power houses likely to be damaged.

Townships like Chungthang, Dikchu, Singtam, Rangpo are vulnerable.

Loss of life and property likely.



Lanco Teesta Hydro Power Singtam

Teesta V NHPC Dikchu Dam

Teesta III Lower Dam NHPC Rimbik

Teesta IV Lower Dam NHPC Kalijhora

# Second Field expedition

Second Expedition to South Lhonak Lake was carried out in September 2016 .

The expedition team consisted of members from :

✓Sikkim State Disaster Management Authority, Govt. Of Sikkim.

✓Department of Science and Technology and Climate Change, Govt. Of Sikkim.

✓Indo Tibetan Border Police (ITBP)

✓Team from SECMOL, Ladakh

# Mitigation

Engineering intervention not feasible due to threat of dead ice melting.

Siphoning of lake water the most viable option.

Appointed Mr. S Wangchuk of SECMOL, Ladakh as consultant to implement siphoning technique.

Installation of sensor to monitor water level.

# Mitigation

Multi departmental expedition to South Lhonak Lake was carried out in September 2016.

8 inch dia heavy duty HDPE pipes customized by manufacturer used for Siphoning of lake water.

3 pipelines of 130 – 140 mtrs installed for siphoning.

150 litres per second of siphoning achieved.

2 mtrs of Lake water expected to be drained within two months.


09.09.2016 11:04

# Third Field expedition

Third Expedition to South Lhonak Lake was carried out in September 2017.

ITBP and team from SECMOL were the part Expedition.

Findings:

✓Sensor to monitor water level collided with floating icebergs.
✓Certain sift in river course was observed.
✓Pipe installed for siphoning was displaced as it was not anchored properly.

# Re- installed of Pipes

Pipe installed for siphoning was re- installed and anchored.

Sensor to monitor water level could not be fixed as it was submerged in water.

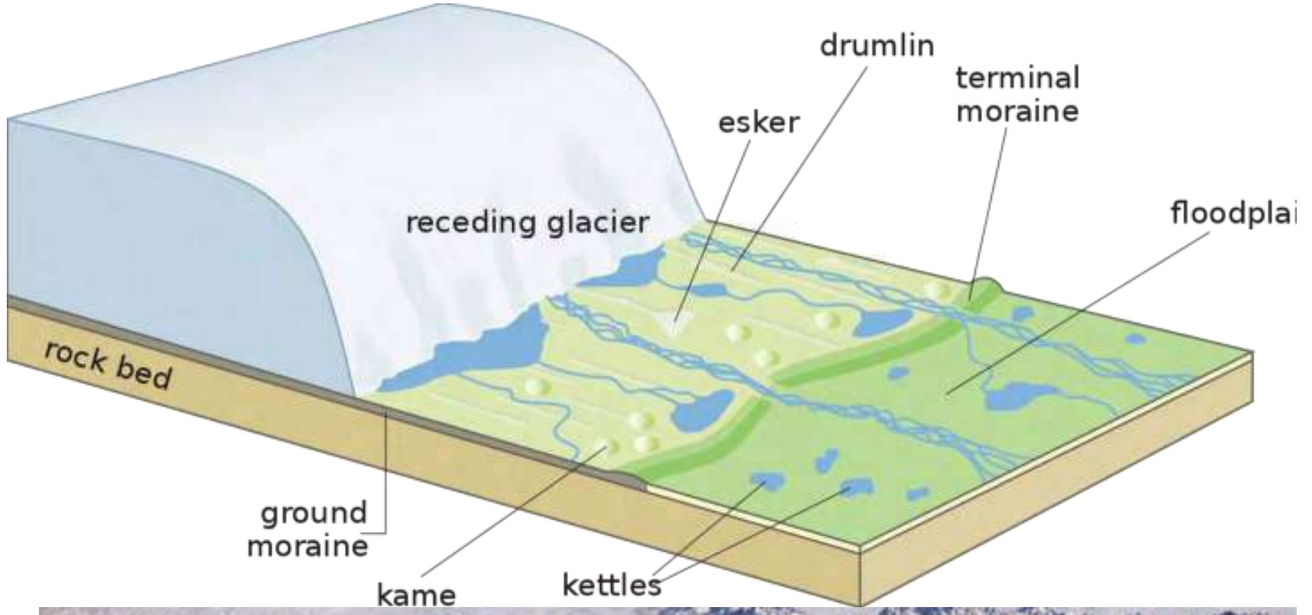
More pipes had been transferred for future mitigation.

# Himalayan Glacier Receding:

## A Cry from the Roof of the World

The Himalayan glaciers, often referred to as the **"Third Pole,"** are ***undergoing alarming recession***, posing a grave threat to global ecosystems.

Rising temperatures, linked to climate change, are accelerating the melting of these ancient ice reservoirs**, impacting downstream water resources and endangering vulnerable** communities




**Important Statistics**
**4rth October 2023 Floods of Sikkim**

| | |
|---|---|
| No. of Villages affected | 100 |
| Population affected | 88400 |
| No. of Human Lives Lost | 42 |
| No. of people missing | 77 |
| No. of persons with grievous injury | 26 (All are hospitalised) |

# Important Statistics

| | |
|---|---|
| No. of Relief Camps Opened | 30 |
| No. of inmates in the Relief Camps | 7025 |
| No. of Bridges washed away | 33 |

# State is Limping Back to normalcy

**The situation in Singtam, Rangpo, Dikchu and Sirwani is improving**

**Gangtok – Rangpo Road is open two ways**

**Melli – Teesta is open one way**

**Teesta – Siliguri is open both ways**

**Gangtok to Siliguri is open via Munsong, Lava and Malbazar for light vehicles alternatively**

**Gangtok to Siliguri is open via Reshi, Algarah, Lava, Gorubathan and Damdim for Heavy vehicles**

# Efforts taken by the State Administration

**A team of Police Personnel led by DIG/Range/North & East was the first to reach Chungthang by foot on 5.10.2023**

**The team carried Police Wireless Communication Sets, Repeater, Generator and Technicians**

**The team was successful in establishing the communication on 8.10.2023**

**SDRF reached Chungthang by foot on 6.10.2023**

**One team NDRF reached Chungthang by foot on 7.10.2023**

**One team of NDRF has reached Mangan on 8.10.2023 and proceeded to Chungthang on 9.10.2023**

# Details of rescue operations by ITBP

**On 5th October 2023:** 9 Tourists from Dzongu

**On 7th October 2023:** 10 Tourists from Dzongu

56 Civilians from Chungthang

6 Employees of Sikkim Urja Limited tunnel

(1 dead body was recovered)

# Challenges still persisting

**So far no road connectivity to Chungthang, Lachung and Lachen and villages along and beyond them (13 number of villages and hamlets)**

**DG/BRO came to Sikkim on 6th October 2023 and visited the affected areas.**

**BRO has proposed for an alternate road to Chungthang via Toong-Naga. However, the construction of this new motorable road is likely to take more than a month**

**Efforts to connect Dzongu, Chungthang and beyond by other means are being taken up.**

**A Bailey Bridge is proposed to be launched over Teesta River at Nampridang**

**Foot Bridges are being constructed by the State Administration and Central Agencies**

**for restoring connectivity to the cut-off areas.**

**One foot bridge was successfully constructed over River Teesta near Chungthang on 8/10/2023.**

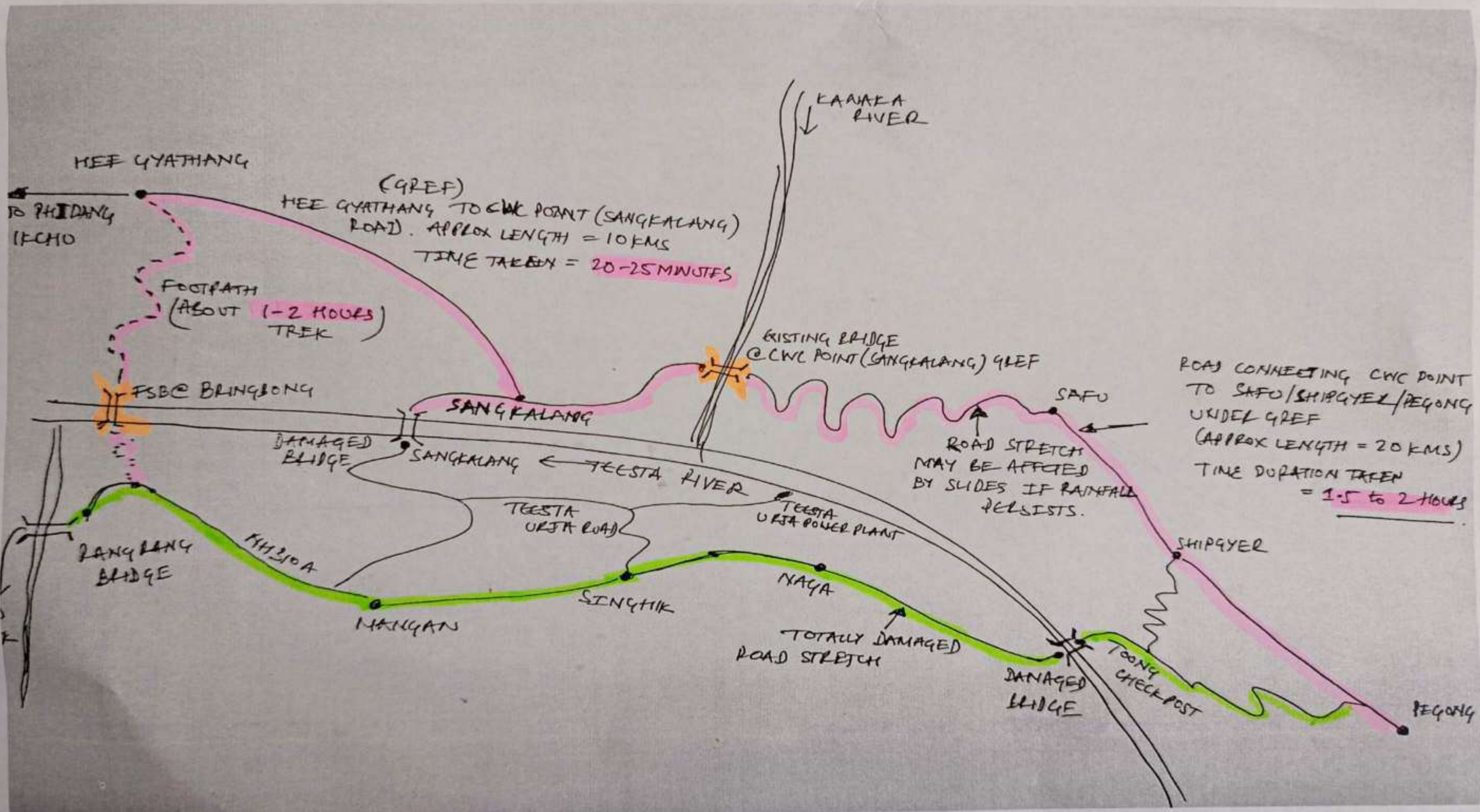
# Other issues

**Army Ammunition Depot at Munshithang (above Chungthang) has been washed away by the floods**

**Arms/Ammunition/Explosives are scattered along the Teesta Basin and poses a threat to the public. This is hampering the clearance of debri/sludge near the river side habitations**

**Warnings have been issued to the public to inform the local police if any ammunition/explosive is sighted to avoid any mishaps**

**Army is carrying out controlled detonation of such ammunitions**


HEE GYATHANG
TO PHIDANG (ECHO)
(GREF)
HEE GYATHANG TO CWC POINT (SANGKALANG) ROAD. APPROX LENGTH = 10 KMS
TIME TAKEN = 20-25 MINUTES
FOOTPATH (ABOUT 1-2 HOURS TREK)
KANAKA RIVER
EXISTING BRIDGE @ CWC POINT (SANGKALANG) GREF
ROAD CONNECTING CWC POINT TO SAFO/SHIPGYER/PEGONG UNDER GREF (APPROX LENGTH = 20 KMS) TIME DURATION TAKEN = 1.5 to 2 HOURS
FSB@ BRINGBONG
SANGKALANG
DAMAGED BRIDGE
SANGKALANG
TEESTA RIVER
SAFO
ROAD STRETCH MAY BE AFFECTED BY SLIDES IF RAINFALL PERSISTS.
TEESTA URJA ROAD
TEESTA URJA POWER PLANT
SHIPGYER
RANGRANG BRIDGE
NH 310 A
SINGTHIK
NAYA
MANGAN
TOTALLY DAMAGED ROAD STRETCH
DAMAGED BRIDGE
TOONG CHECK POST
PEGONG

# Chungthang Sikkim Urja Dam

Before

After

# Chungthang Bridge

Before

After

# Toong Bridge

Before

After

# Sanklang Bridge


Before

After

# Phidang Bridge

Before

After

# Kanaka Bridge


Before

After

# Teesta Stage V, Dikchu

Before

After

# Tanak Bridge


Before

After

# L.D. Kazi Bridge, Sirwani


Before

After

# Teesta Stage VI, Sirwani

Before

After

# Indreni Bridge, Singtam

Before

After

# Atal Bridge, Rangpo


Before

After

# Sustainability in Himalayan Geographic Context

*Sustainability* in the Himalayan geographic context i**nvolves the ability to meet the present and future needs of the region's population while maintaining the balance and resilience** of its ecosystems.

It considers the **conservation of biodiversity, responsible resource management, and the development of policies that ensure the well-being of communities** without compromising the ability of future generations to meet their own needs in the unique environmental setting of the Himalayas.

# The Use of Indigenous Traditional Knowledge in Climate Change Strategies

*Indigenous communities in the Himalayan region have developed a deep understanding of their local ecosystems over generations, and their traditional knowledge can contribute significantly to climate change adaptation and mitigation efforts.*

**Ecosystem Management and Biodiversity Conservation**

**Water Resource Management**

**Agroecology and Sustainable Agriculture**

**Community-Based Adaptation**

# Himalayan Glacier Receding

01 **Climate Change Impact:** The correlation between rising global temperatures and Himalayan glacier recession.

02 **Water Security at Stake:** The critical role Himalayan glaciers play in sustaining major Asian rivers, affecting billions downstream.

03 **Ecosystem Disruption:** The ripple effects on biodiversity, ecosystems, and weather patterns triggered by glacier retreat.

04 **Socioeconomic Consequences:** The potential humanitarian crises and challenges faced by communities relying on glacier-fed water sources.

# Risks in context of Indian Himalayan states

**01** Earthquake Risks in Indian Himalayas

**02** Landslide Risks in India

**03** Flood Risks in Indian Himalayas

***High susceptibility !***

# Over Tourism in Himalayas

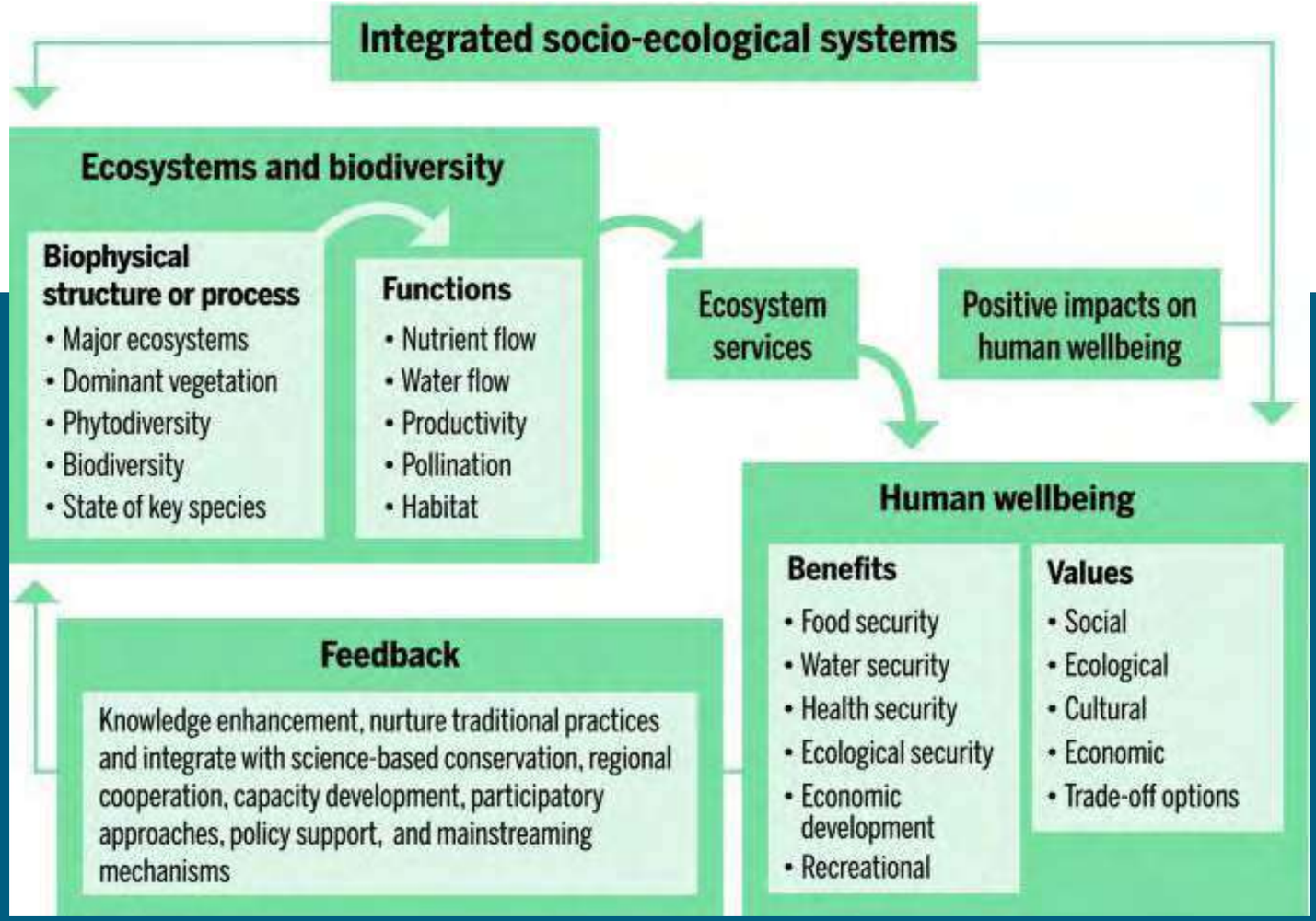
01 Everest Environmental Expedition

02 The world’s highest junkyard

# Biodiversity and Ecosystem Services in Himalayas

**01** The significance of biodiversity in the Indian Himalayas

**02** Impact of disasters on ecosystems and related services



# Socioeconomic Factors in Indian Himalayas

**01** Socioeconomic factors specific to Himalayan states in India

**02** Poverty, limited infrastructure, and access to education and healthcare in the region

# Governance and Disaster Management in India

# Community Resilience in India

# Sustainable Development Goals (SDGs) in India

**Aligning the discussion with the United Nations SDGs relevant to Indian Himalayan states**

**Achieving sustainability goals can enhance resilience in the region**

## 4 priorities of Sendai framework

Understanding disaster risk.

Strengthening disaster risk governance to manage disaster risk.

Investing in disaster risk reduction for resilience.

Enhancing disaster preparedness for effective response and to "Build Back Better" in recovery, rehabilitation and reconstruction.

## Paris Agreement

The Paris Agreement's central aim is to strengthen the global response to the threat of climate change by keeping a global temperature rise this century well below 2 degrees Celsius above pre-industrial levels and to pursue efforts to limit the temperature increase even further to 1.5 degrees Celsius

# International Collaboration in India

- **The role of global cooperation in DRR**
  - Knowledge and Information Sharing
  - Resource Mobilization
  - Capacity Building
  - Risk Reduction Strategies
  - Resilience Enhancement
- **International agreements and frameworks**

SENDAI FRAMEWORK FOR DISASTER RISK REDUCTION 2015-2030

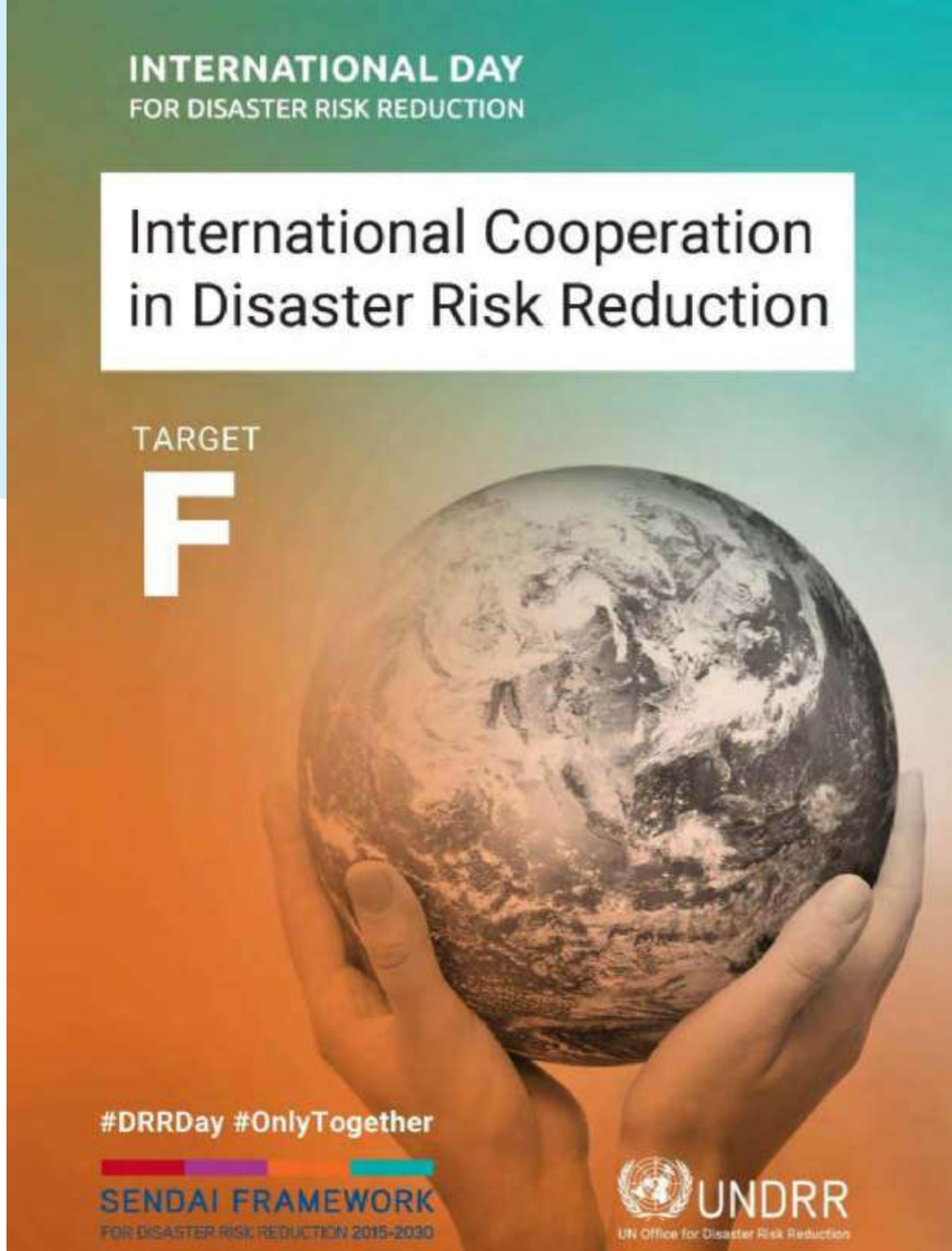
International Strategy for Disaster Reduction

United Nations Framework Convention on Climate Change

PARIS AGREEMENT

ASEAN Agreement on Disaster Management and Emergency Response Work Programme 2010 - 2015

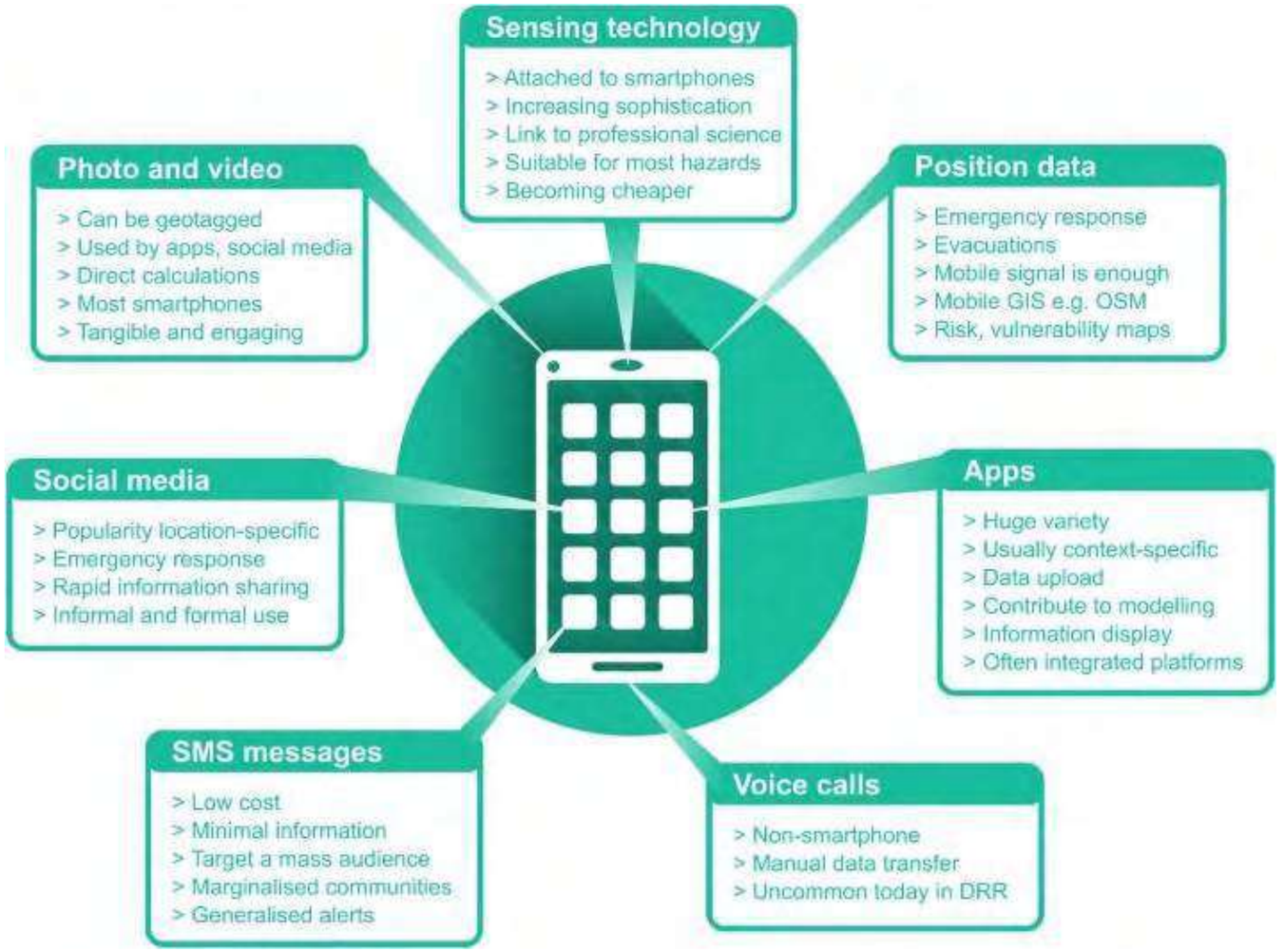
Hyogo Framework for Action 2005-2015: Building the Resilience of Nations and Communities to Disasters



# Technology and Innovation in India

the role of technology in early warning systems and disaster response

Innovative solutions for sustainable development in Indian Himalayan states



# Future Challenges and Opportunities in India

**01** Challenges due to climate change and population growth in Indian Himalayan states

**02** Identifying opportunities for sustainable development in the face of adversity

# Thank You